NUMBER EIGHT NOTES FROM THE SHOP

Woodsmith™

JOINERY TECHNIQUES:
AN EASY APPROACH TO
THE MORTISE AND TENON

TECHNIQUE AND PROJECT:
DETAILED PLANS FOR A
FRAME & PANEL CABINET

7 53543 00008 1

Woodsmith

Number Eight March, 1980

Editor
Donald B. Peschke
Graphic Design Consultants
David C. Webster
Jon Snyder
Contributing Editor
Adolph E. Peschke
Subscription Manager
Linda Hill

Subscription Questions? Call 800-333-5075, 8:00 AM to 5:00 PM, Central Time, Monday through Friday. Fax: 515-283-0447.

WOODSMITH® (ISSN 0164-4114) is published bimonthly (February, April, June, August, October, December) by Woodsmith Publishing Co., 2200 Grand Ave., Des Moines, Iowa 50312.

Talking Shop

I feel a little uneasy about this issue. Those of you who have been reading *Woodsmith* for a while know that this issue is a departure from the usual format. But we have a lot of new subscribers. And that's what's bothering me.

I've been trying to stick to a format that includes a variety of large furniture projects, small projects, and techniques. But the articles on frame and panel carcass construction and mortise and tenon joinery in this issue kind of got out of hand.

I feel both of these subjects deserve the space they've received. But I also understand that if they're not of interest to you, this is kind of a wasted issue.

Without too many more apologies, I would like to say that I think the information in this issue is worth the space. But we'll get back to the usual format in the next issue.

NOTES AND THOUGHTS

I jotted down several things I wanted to mention, so here goes.

COMPUTER. We just got a computer. It's a marvelous contraption that keeps track of subscriptions, prints labels, and does some of the accounting work. However, we had to switch over all of the old records to the computer. I even got involved in the process of typing (or "keying in", as they say) all of the names and addresses. So there may be an error or two on your label (especially if it's one I typed). You might check over the address label and let us know of any errors.

There are two codes above your name. The one in the upper left-hand corner of the label is your ZIP code plus the first four letters of your last name. This is the code we use to find your name in the computer. If there are any corrections to be made, be sure to tell us that code (even if it's wrong). And, especially if you change your address, include that code.

The code in the upper right-hand corner is the date of your last issue. You may want to check your records to make sure we have the correct date. Again, let us know of any errors.

TIME. We've been receiving a lot of new subscriptions, as well as requests for back issues. It's been a real struggle trying to keep up and get things out on time.

Most magazines ask that you allow 6 to 8 weeks for delivery of your first issue. We're trying to cut that time in half. One problem is the amount of time your order and the issues spend in the hands of the Post Office. We try to process all requests as quickly as we can, but it does take time. If you've ordered back issues, please allow at least three weeks for delivery. But if it goes more than four or five weeks, drop us a note. It's helpful if you include information about what you ordered and the date you sent it. Thanks.

TIPS & TECHNIQUES. In *Woodsmith* Number Seven we started an article called Tips & Techniques. This will be your page. If you have any shop tips, woodworking techniques, jigs or set-ups, etc. send them in. You'll receive a minimum of $5 for a tip and more for techniques and jigs.

COMING UP. In the next issue I'll get back to our usual format. I'm planning some outdoor projects, and three or four ways to make wooden hinges. Also, the first round of reader tips will appear.

QUESTIONNAIRE RESULTS

A couple of issues back I mentioned that I wanted to do a questionnaire. Well, we got a start on that when we mailed out renewal notices recently. It was a short questionnaire, but it was a start.

I included a question on what power tools you currently own. About 75% own a table saw and 60% own a radial-arm saw. These percentages add to more than 100% because about 40% own both. (That surprised me a little). Naturally, there were a lot of requests for more information on the radial-arm saw. I will start including that.

I also asked for suggestions that would make *Woodsmith* better. Here's a sampling of the responses.

Make it bigger, more pages. I hope by the end of the year we can add four more pages. *Include information on tools and equipment.* That's what I hope to put on the extra four pages. *More on the radial-arm saw and lathe.* Will do.

Some said, *Keep attuned to the skills of the neophyte and intermediate hobbyist;* while others said, *Have articles for people with more experience.* It's difficult to go in both directions. My personal preference is to stick to good basic projects with an interesting twist.

More contemporary designs. And, *Skip all that contemporary stuff.* In the past few years I've been seeing some beautiful new designs in furniture. I'd like to try some modern (but not too far out) designs. I think some of these new designs can offer an entirely new way of working with (and looking at) things made of wood.

NEXT MAILING: May 1, 1980

Joinery: Mortise & Tenon

THE BASICS OF THE MORTISE AND TENON JOINT

It's difficult to talk about the mortise and tenon joint for two reasons. First, it's not just one joint, it's dozens of variations. But what's worse, the mortise and tenon seems to intimidate many woodworkers. Like the dovetail, it has the reputation of being reserved only for those craftsmen with years of experience.

It shouldn't be that way.

The fact is that cutting a perfect mortise and tenon joint is really not all that difficult. Of course, there are several ways to go about it, some difficult, some relatively easy. But the method described on the next two pages is, I think, one of the easiest ways to achieve good results.

THE MORTISE AND TENON IN GENERAL

The mortise and tenon joint is used when joining two pieces at right angles — a rail and a stile, or a rail and a leg.

The simplest form of a right-angle joint is a butt joint. However, a butt joint does not provide a proper gluing surface because you're joining the short grain of the rail (the end of the rail) with the long grain of the stile (the edge).

The mortise and tenon solves this problem by providing a proper gluing surface on both pieces. As shown in Fig. 1, the cheeks of the mortise (long grain) are glued to the cheeks of the tenon (long grain), thus providing an adequate gluing surface.

In addition to solving the gluing problem, this joint also has very good mechanical strength — it will hold together (to some extent) without glue, nails, etc. This mechanical strength is the result of the tenon locking in the mortise, and also the shoulders of the tenon in contact with the stile.

There are some general guidelines for cutting a mortise and tenon joint. Both the mortise and tenon are usually one-third the thickness of the stock. However, this can (and should) be altered to fit the application of the joint.

It may be beneficial to increase the thickness of the tenon for more strength. But, basically you're faced with deciding on a balance between a wide (and strong) tenon or a narrow tenon with the mortise cheeks thicker and stronger.

THE MORTISE

There are several types of mortises used in frame and panel work and carcass construction. Four of them are shown in Figure 2.

The *slip* or *open mortise* (Fig. 2a) is really a slot cut at the end of a board. This mortise is easy to cut, but has little mechanical strength. It relies mostly on the bond between the glued surfaces. Because of this it is often strengthened with the addition of pins through the mortise cheeks and the tenon.

The *through mortise* (Fig. 2b) is, as the name implies, cut all the way through a board from edge to edge, or face to face. Here again the tenon can be secured in the mortise with the use of pins.

The *blind mortise* (Fig. 2c) is cut either on the edge or face of a board, but stops before going through to the other side. This type of mortise is the one most often used in frame and panel work. Often it is cut so it can be teamed up with a haunched tenon (shown in Fig. 1).

The *twin mortise* (Fig. 2d) is actually a variation of either the through or blind mortise. I'm showing this variation because it brings up one important rule: A mortise is always cut with the grain, never across it. There is often the temptation to cut a single mortise across the grain when a twin mortise, with the grain, should be used.

THE TENON

The tenon is designed to meet the two basic criteria of the mortise and tenon joint: to provide a gluing surface along with mechanical strength. The shoulders of the tenon give the joint its mechanical strength, while the resulting cheeks provide the gluing surface.

In its simplest form a tenon has two primary shoulders to provide the bare minimum of mechanical strength (Fig. 3a). The addition of two secondary shoulders (Fig. 3b) creates resistance to any up-and-down tensions on the rail. These secondary shoulder need not be very deep, no more than ⅛" is necessary.

The haunched tenon (Fig. 3c) with two primary and one secondary shoulder employs the haunch for extra strength to resist twisting.

Twin tenons (Fig. 3d) are cut with the primary shoulders on the edges (thickness) of the board rather than on the faces (width). Generally each of the shoulders and tenons are of equal thickness.

CUTTING THE MORTISE AND TENON

The basic difficulty in cutting a mortise and tenon joint arises from the fact that it's two distinct operations. But the result of both operations must be one perfectly matched joint.

So, let's get to it. Which is cut first, the mortise or the tenon? I think the best results are achieved by cutting the mortise first. If something goes wrong and the joint doesn't fit properly, it's usually a good deal easier to alter the size of the tenon to fit the mortise, than the other way around.

FIGURE 1

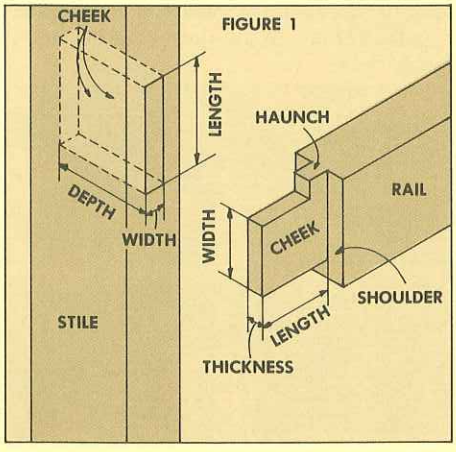


FIGURE 2

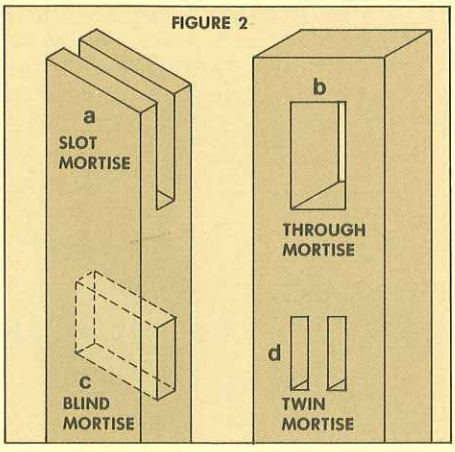
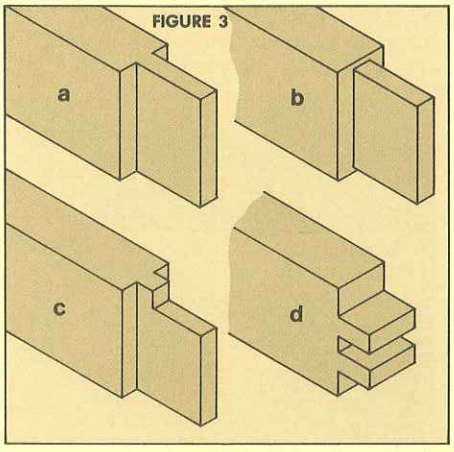


FIGURE 3



The Slot Mortise

AN EASY APPROACH TO CUTTING A MORTISE

Of the various types of mortises, the blind mortise seems to present the most problems. And, wouldn't you know it, it's also the one used most often in frame and panel work. So, in this article I thought I'd concentrate on cutting a blind mortise.

A blind mortise is really nothing more than a rectangular hole cut to a specified depth. There are several ways to go about cutting this rectangular hole. One way is with a mortiser — a very expensive machine (similar to a drill press) designed specifically for this purpose. A less expensive way to go is with a mortising attachment mounted to your drill press. And, a third alternative is to chop the mortise by hand with a mortise chisel. But this does take some hours of practice.

THE SLOT MORTISE

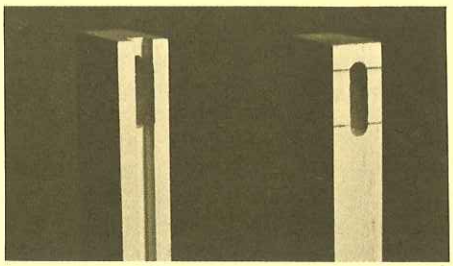
So, now the question is, how can you go about cutting a square-cornered mortise without a big investment in special attachments, or hours of practice by hand? You don't. At least, not if you cut a slot mortise.

A slot mortise is the European method of cutting a mortise. It's cut with a drill or router bit and, thus, has rounded corners. The corners of its companion tenon are then rounded to a precise fit.

I think the slot mortise makes a lot of sense. It can be cut easily on a drill press with no special attachments, and there's no need to worry about square corners. That makes things a good deal easier (and far less expensive).

GENERAL GUIDELINES

When marking the boundaries of a mortise I follow these general guidelines. The *width* of the mortise should be (in theory) one-third the thickness of the stock. In practice, the width is actually determined by the diameter of the bit



being used. (Usually ¼", ⅜", or ½", whichever comes closest to the "theory".)

The *length* of the mortise is actually determined by the width of the tenon. Basically, you want to make this dimension as large as possible since this, to a great extent, determines the amount of gluing surface in the joint.

The *depth* of a blind mortise is also important in determining the amount of gluing surface. In general, I cut a blind mortise two-thirds of the way through the stock.

MARKING THE BOUNDARIES

The basic steps in cutting a mortise are shown in the drawings below. This example shows cutting a blind mortise at the end of a ¾"-thick by 1 ½"-wide stile. The boundaries of the mortise are ¼" wide, 1" long and 1" deep.

Basically, there are three steps: marking the boundaries, roughing out, and cleaning to final shape.

To mark the boundaries (Fig. 1) first I draw lines on the stile to mark the length of the mortise. Each line marks the point where the bit will engage; however, the hole will actually extend ⅛" to the outside of the line. So, for a 1"-long mortise, the lines should be ¾" apart.

Though the tenon can be adjusted to fit an off-center mortise, it's best if the roughing-out holes are exactly centered on the stile. To do this, place the 1" mark of a ruler on one edge of the stile and the 2" mark on the other edge. The 1 ½" mark is then at the center of the stile.

One way to check this is to drill a 1/16"-deep hole on the center line of a try-piece. Flip the try-piece end for end and drill a second hole. If this second hole lines up with the first, you're at the exact center.

ROUGHING OUT

Roughing out the mortise is done by drilling a series of holes. I use a brad point twist bit (available from *Leichtung* catalog). I wouldn't recommend using high speed twist bits or spade bits, you'll just have headaches.

To drill the series of roughing-out holes, I clamp a fence to the drill press table (Fig. 2). Hold the *face* side of the stile firmly against the fence and adjust the fence so the bit engages exactly on the center line of the stile.

Drill the outside two holes first, then clean out the section remaining (Fig. 3). The bit will probably argue at this point, but you can get most of it drilled.

CLEANING UP

Once the mortise is roughed out, you must clean up the cheeks of the mortise. This can be done with a sharp bench chisel. Simply pare the rough cheeks down to the full depth of the mortise.

If you have a lot of mortises to clean, it may be worth the time to chuck a straight router bit into the drill press, raise the table and realign the fence.

When I use this router bit method, I set the speed of the drill press at about 2500 RPM. Then I lower the straight bit into the rough mortise only about ¼". While holding the stile firmly against the fence, I slide the stile along the fence so the bit cleans out the mortise. Things will chatter a little, but the slow speed seems to offer more control for stopping at the ends of the mortise. Successive passes are made in this manner, lowering the bit ¼" each time.

FIGURE 1

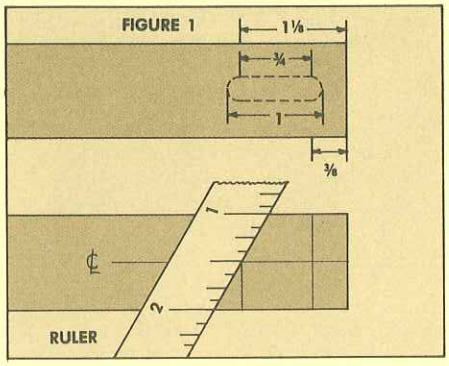


FIGURE 2

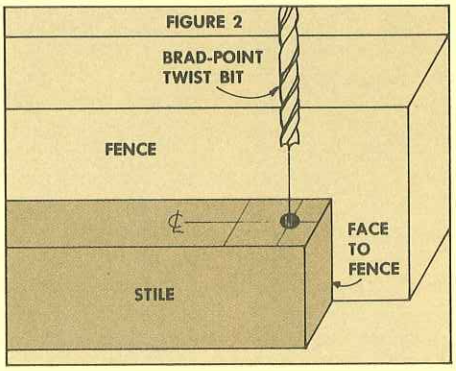
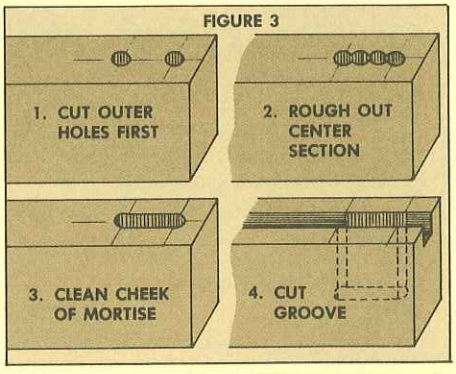


FIGURE 3



The Tenon

CUTTING TENONS WITH THE EMPHASIS ON THE SHOULDERS

Once the mortise is cut, the tenon is cut to fit. And, as always, there are several ways to go about this.

You can cut the tenon by hand with a back (or tenon) saw. Or, it can be cut on a table saw with the aid of a tenon jig, using one blade and making a separate pass for each cheek, or using two blades and cutting both cheeks at once.

In all of these techniques, the procedure is to cut the cheeks first and then make a cut at the shoulder. However, in doing this there's a tendency to concentrate only on the fit of the tenon in the mortise while forgetting another critical measurement.

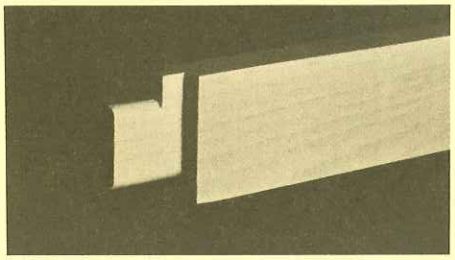
In most applications rails will have tenons at *both* ends. The critical measurement then is the distance between the shoulders of these two tenons. If, for instance, you're making up a frame with three rails (top, middle, and bottom), the shoulder to shoulder distance must be exactly the same on all three rails.

The method described here for cutting the tenon is certainly not one of the typical approaches. But, I think it does meet this shoulder-to-shoulder problem nicely, and solves a few others along the way.

The basic technique is to cut the tenon by making a series of passes over a dado blade. Since the first cut is made at the shoulder line, both the shoulder and the thickness of the tenon are established with one cut.

CUTTING THE TENON

The first step is to set the height of the dado blade, Fig. 1. (I use two blades in tandem for a ¼"-wide cut.) Place the *face* side of the stile down on the table with the mortise up against the blade. Now



adjust the height of the blade so it just touches the top of the bottom cheek. Thus, even if the mortise is slightly off center on the stile, the placement of the tenon will be "off" by the same amount.

To cut the tenon, clamp a spacing block to the fence, Fig. 2. The distance between the block and the *left* side of the blade should be the approximate length of the tenon (depth of the mortise).

Push the end of the rail up against the block and use a miter gauge to guide this first (shoulder) cut. Then repeat until you have, in effect, a half-lap joint. If you're cutting a number of rails, make this cut of all rails at the same time. Also, it will help later to make this cut on a try-piece that's exactly the same thickness as the rails.

Since you'll most likely need to cut a tenon on the other end, mark the shoulder-to-shoulder distance you want, Fig. 3. (This will be the distance between the stiles.) Reset the fence (with the block) and cut these "half-laps" on the other end. Again, this cut is only on the face side.

Now you can flip the rail over so the face side is up. Reset the height of the dado blade using the mortise as a guide.

However, before cutting the rails, first make this cut on the try-piece, and test the fit of the tenon in the mortise. You'll only be able to fit a corner of the tenon in the mortise, but it should be enough to tell you if you're in the ballpark, Fig. 4.

Make all of these cuts at one end of each rail. Then, as before, mark off the shoulder-to-shoulder distance, and cut the other end of all rails.

If you need to cut secondary shoulders or a haunch at this point, the process is the same except the rail is on an edge instead of a face. In the case of a haunched tenon (Fig. 5), the haunch should fit neatly in the groove.

FINAL FITTING

Now you have a square tenon for a round mortise. So, all you have to do is round-off the corners of the tenon to fit the mortise. I use a four-in-hand rasp to do this. This type of rasp has smooth edges so there is no danger of marking up the shoulder of the tenon with file marks.

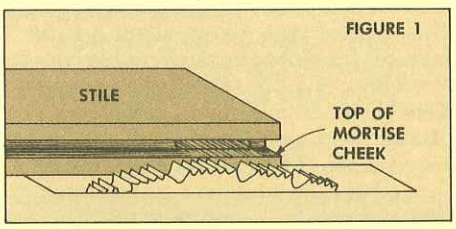
The end of the tenon should be about $\frac{1}{16}$" short of fully seating on the bottom of the mortise. The resulting void can fill with excess glue.

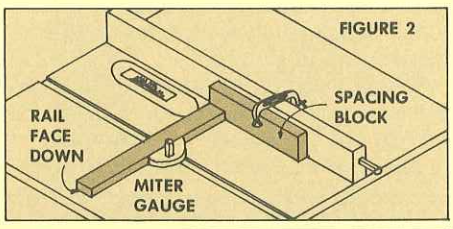
The tenon should fit hand tight in the mortise. If you have to hammer it in, you'll probably split the cheeks of the mortise. But if it goes in with a kind of "sssschunk", that is, both cheeks of the mortise engaging the tenon until it seats fully on the shoulders, you're okay.

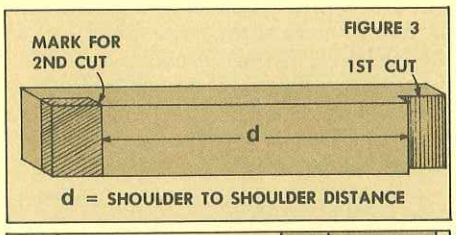
DOUBLE TENON

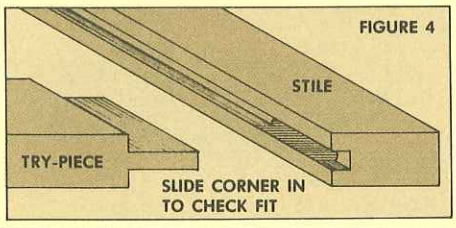
A double tenon is cut in a similar manner as described above. The first two cuts are made leaving one large tenon at the end of the board, Fig. 6. These cuts should align with the outside cheeks of both mortises.

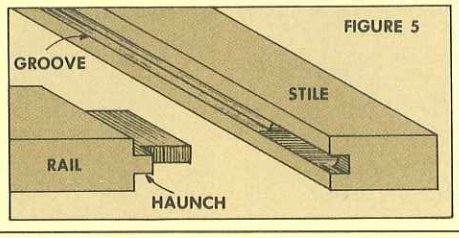
To make the final cut, stand the rail on end and clamp it to a tenon jig. The width of this final cut is the same as the width of the cheek between the double mortise.

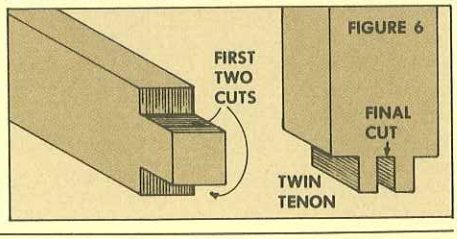












Frame and Panel

PUTTING IT ALL TOGETHER

A common application of the mortise and tenon joint is in frame and panel construction. Whether the frame and panel is a door, the side of a cabinet, or a web frame, the basic construction is the same.

However, in this application there are two more steps involved besides cutting the mortise in the stile and the tenon in the rail. Some provision must be made for holding the panel in the frame. And, of course, you must also make the panel.

THE PANEL GROOVE

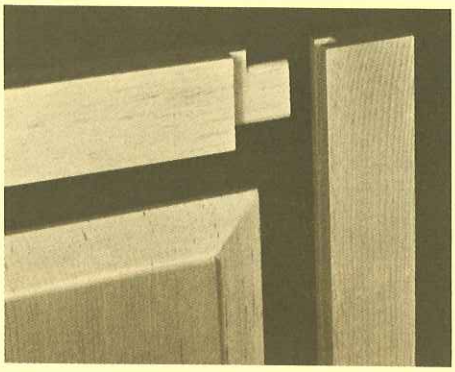
There are several alternatives for holding the panel in the frame. The method shown here is one of the most common. A groove is cut in both the stile and rail and the edges of the panel are beveled or rabbeted to fit in the groove.

It's best to make the width of this groove the same as the width of the mortise. The depth of the groove depends to some extent on the type of panel being used and its overall dimensions.

If, for example, a plywood panel is to be used, a ¼"-deep groove provides plenty of room. On the other hand, if a solid wood panel is inserted, the depth of the groove must be enough to allow for the expansion and contraction of the panel from season to season. As with any piece of solid wood, these changes will occur mostly in the width of the panel, to some extent in the thickness, and very little in the length.

For most applications where the panel is less than 12" to 14" wide, a ¼"-deep groove will be adequate. In this case the panel is cut a total of ⅛" to 3/16" narrower than the groove-to-groove width to allow for expansion.

I cut this groove immediately after the mortises are cut in the stiles. I place the mortise over the dado blade with the face of the stile toward the fence. Then I move the fence over to the stile. (This operation is a little awkward. If the dado blade is lowered so only a small portion sticks up, then the stile won't rock on the blade.) All of this can be tested on a try-piece first.



I rip the groove the full length of the stile. Then I go ahead and cut this groove in the rail (again, with the face toward the fence) *before* the tenons are cut. This assures that the grooves will line up once the frame is assembled.

By cutting the groove the entire length of the stile, there will be a small void left at the end of the stile. This void is neatly filled with the haunch of a haunched tenon. Not only are you filling this void, but the haunched tenon lends strength to the joint, Fig. 2.

THE PANEL

Panels can be either plywood or solid wood. Plywood panels don't have visible borders (shoulders), but they can have a recessed look (Fig. 2a) or be flush with the frame (Fig. 2b). Since plywood has remarkable stability, these panels can be glued in the frame to prevent them from rattling around.

When solid wood panels are chosen, there are a few problems. First, the edges of the panel must be shaped in some way to fit in the groove. This can be done by rabbeting the shoulders (Fig. 2c) or cutting a bevel at 12° to 15° (Figs. 2d and 2e). In all of these three examples the border is cut around the edge of the panel, which in effect creates a raised portion, the field.

A solid wood panel can never be glued into the frame, or it will surely split. To prevent the panel from inadvertently being glued at the corners (where some glue from the joint could seep into the groove), trim the corners slightly and apply furniture wax to the edges of the panel before gluing up.

THE GLUING UP

Before gluing up, I finish sanding all areas that will be difficult to sand later — the inside edges of the stile and rail, and the border of the panel. Then I dry clamp the frame (with the panel inside) to check the fit. (It's better to correct any problems now than to have an unwelcome surprise at the gluing up stage).

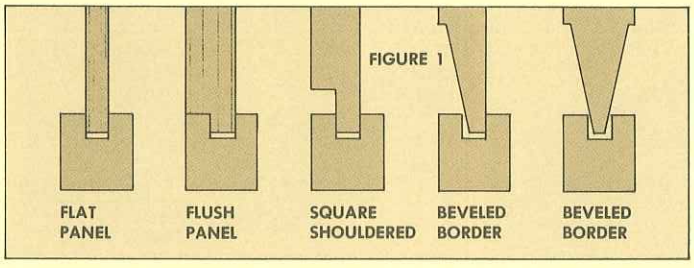
A bar or pipe clamp at each rail is all that should be necessary. As long as the tenons fit snugly in the mortises, there should be no need for extra C-clamps at these joints.

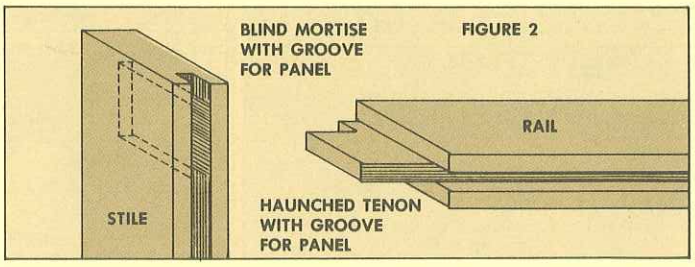
While dry-clamped, I check three things. First, I make sure the frame is square and free of twist. Then I check to see if the panel is free to move in the groove. And finally, I check the fit of the shoulders of the tennons against the edge of the stiles.

If the shoulders do not fit tight against the stile, it could mean one of five problems: 1) The frame is not square or is twisted; 2) The tenon shoulders are not cut square with the rail; 3) There's a small chip of wood in the mortise preventing the tenon from fully seating; 4) The tenon is too long and needs to be trimmed; 5) The shoulder on the back side meets the stile but the shoulder on the front is cut too short.

Once everything checks out, you're ready to glue up. I spread a thin layer of glue in the cheeks of the mortise, on the cheeks of the tenon, and just a complimentary amount on the shoulders of the tenon.

I usually use an aliphatic resin glue (*Titebond* or *Elmer's* Carpenter's Glue). This type of glue allows about 5 to 10 minutes for gluing up (10 minutes may be stretching it a bit). For more assembly time (15 to 25 minutes) I might use a plastic resin glue *(Weldwood)*, but this requires about 12 hours of clamping time.





Wall-Hung Cabinet

WITH A RAISED-PANEL DOOR

In much cabinetwork a solid-wood frame is added to the front of the cabinet. This is particularly common on kitchen cabinets where the frame is used to hide the edges of the plywood or composition board used to make the carcass.

I decided to use the same idea on this wall-hung cabinet, but I wanted to do something a little different. I put a double bead-cut on the inside edge of the frame and then mitered the ends to "frame" the raised-panel door.

As shown in the Cutting Diagram in Fig. 2, this cabinet is made from just two 1 x 6 pine boards, 8-feet long. I cut the top, bottom and sides to the lengths shown in the Materials List. The top is joined to the ⅜" x ⅜" rabbets. However, the rabbets on the bottom piece are let into ⅜" x ⅜" dadoes as shown in Figure 2. Finally, a ¼" x ⅜"-wide rabbet is cut along the back of all of these pieces for the cabinet's back.

The framing pieces are cut to the length and width. Then I used a three-bead cutter blade on a molding head to make the bead cuts on the edges of the frame pieces. I attached a notched, auxiliary (wood) fence to the table saw fence, and positioned the notch over the bead cutter so it would cut only two beads.

The ends of the frame pieces were then mitered. The ⅜" x ¼"-deep holes are counterbored on the face of the frame, followed by a pilot hole for No. 8, 1½" woodscrews. The frame is attached to the carcass and the counterbore holes are filled with dowel plugs.

Once the frame is attached, you can measure the opening to get the exact dimensions for the door stiles and rails. These are joined with a blind mortise (¾" deep) and haunched tenon, and grooves are cut for the panel.

The panel is glued up and then cut to fit in the grooves in the door frame. An 8° beveled border is cut on both sides, leaving a ¼" tongue.

MATERIAL LIST

Code	Piece	Dimensions
A	Top & Bottom	¾ x 5½ - 14¾
B	Sides	¾ x 5½ - 24
C	Frame (vert.)	¾ x 1¼ - 24
D	Frame (horz.)	¾ x 1¼ - 15½
E	Door Stile	¾ x 1¼ - 21½
F	Door Rail	¾ x 1¼ - 12
G	Panel	¾ x 10⅞ - 19⅜
H	Shelves	¾ x 5¼ - 14½
I	Back	¼ x 14¾ - 23¼

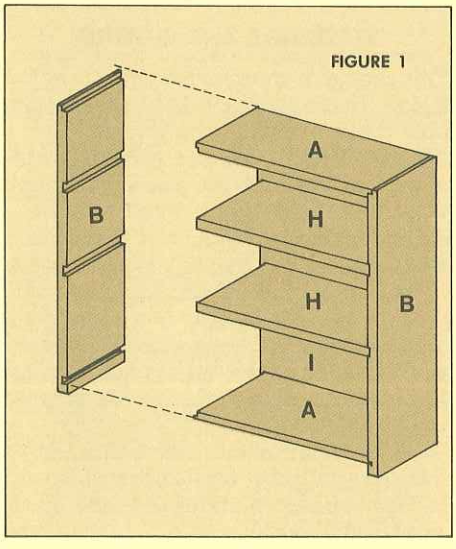


FIGURE 1

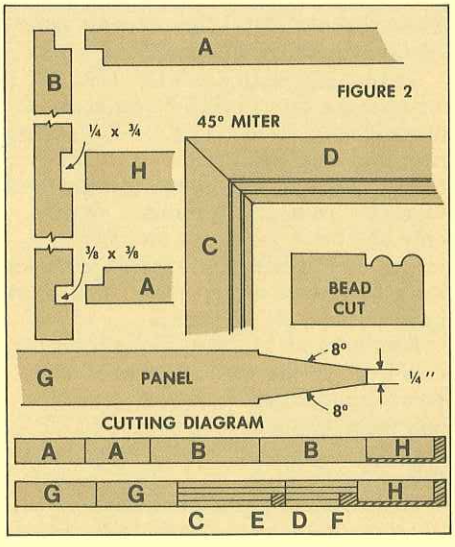


FIGURE 2

Frame and Panel Cabinet

THE BASICS OF FRAME & PANEL CARCASS CONSTRUCTION

The cabinet shown above is frame and panel construction taken to an extreme. It should be said that this is an out-of-the-ordinary design. Almost never do you see a cabinet top that's frame and panel, and rarely do you see frame and panel drawer fronts. But, I figured, why not go all the way with this one?

At first glance this cabinet looks like a lot of work. (It is.) But if you break it down, you're really doing the same thing over and over again. That is, making rails, stiles, and panels, and joining them together. To simplify things I've used only one basic joint: the mortise and tenon. And to complicate things there are three variations of that joint . . . and you have to make 64 of them.

For those of you who haven't thrown this issue in the waste basket at this point (muttering, "Sixty-four mortise and tenon joints, is he crazy?"), I'd like to mention a couple of things about what follows.

Except where specific dimensions are given for the cabinet shown in the photo, this discussion applies to frame and panel construction in general.

Also, most of the detailed information about the mortise and tenon joints has been left out of this article, but it is included in the preceding article.

MATERIALS AND CUTTING

This cabinet is constructed entirely of No. 2 pine. That's right, good old construction pine that's available everywhere. The trick is to find a lumber yard that will allow you to select the pieces you want. Hopefully, these pieces won't have an excessive amount of knots or checks, and will be somewhat free of warp and twist.

I cut around all of the knots and the result was clear pine at much less cost, even allowing for the waste. Of course, you'll have to adjust the *amount* of wood you buy according to the *quality* of wood you're able to obtain. (The Cutting Diagram at the end of this article shows the ideal situation of all usuable wood, but it should give an idea of how much wood you'll need.)

THE SURROUND

The surround (a term I use to refer to the top, bottom, and sides of a cabinet) consists of four frame and panel units. The order of construction for each of these four frame units is to make the frame first and then cut the panels to fit.

Figures 1 and 2 show the construction of the "surround" frames. The top and bottom frames are the same except they take different panels — raised panels on the top, and plywood inserts in the bottom. The final outside dimensions of these frames should be 17″ by 34¼″.

The two frames for the sides (Fig. 2) are identical in construction to the top and bottom; they measure 17″ by 26″.

To build these frames I started by cutting the eight stiles and twelve rails to the length and width shown in the Materials Lists.

I cut slot mortises in all of the stiles first. Then I set up the table saw with a dado blade set to cut a ¼″ x ¼″ groove along the length of the stiles.

Since the grooves in the rails have to match the position of the grooves in the stiles, I went ahead and cut the grooves in the rails *before* cutting the tenons at the ends. All of these grooves were cut with the face side of the piece toward the fence.

As discussed in the preceding article, I use a slightly different method for cutting the tenons. If you choose to use this method, you can set up your saw to cut all of the tenons at the same time. However, no matter what method you use to cut the tenons, the critical measurement is the *distance between the shoulders*, not the overall length of the rail. I've included an extra column in the Materials Lists (with the heading Shld.) that gives this measurement.

There are two different kinds of tenons used in the frame. The upper and lower rails join the stiles with haunched tenons, while the center rail joins the stile with a common tenon.

After cutting and fitting the frame members, I dry-clamped the frames to check the fit of the joints. While the frames are dry-assembled, I also measured the openings for the panels.

THE PANELS

The overall dimensions of the panels are given in the Materials Lists. These dimensions account for the opening in the frame plus ½" (for the ¼" grooves on each side) minus ⅛" (to allow for expansion and contraction from season to season).

The panels in this cabinet are a more modern interpretation of the classic raised panels found on Colonial-style furniture. Instead of beveled borders, the panels are simply rabbeted, producing a square shoulder between the border and the "raised" portion (the field).

The panels on this cabinet are made from ½" finish grade pine. Since this is sometimes difficult to find, (and costs a small fortune) you can certainly substitute ¾" pine.

Glue up enough boards to get the width you need for the panels. Then cut them to the dimensions mentioned above. After cutting the panels to fit in the frames, you'll be cutting rabbets on all four edges of the *face* side of the panel. All of these rabbets are ¼" deep. But, just to keep you on your toes, they vary in width.

The rabbets on the panels on the top frame are all 7/16" wide — allowing ¼" between the frame and 3/16" set into the groove. But the panels for the sides vary, for this reason: The panel should fit loosely in the frame (it is *not* glued in place). Since the panel is loose it will naturally fall to the bottom of the frame, and the panel's field would be off center. So, the rabbets at the top and bottom of the frame are cut to account for this. The rabbet on the bottom is 9/16" wide, and on the top it's only 5/16" wide. These dimensions should center the field in the frame with a ¼" border all around.

(If you're using ¾"-thick stock for these panels, all of these widths apply to the rabbets on the back as well as the front.)

After cutting the rabbets, I rounded the four corners just slightly. I've found the best way to do this is with a four-in-hand rasp. This type of rasp has a smooth edge so you'll only be filing the corner and not disturbing the shoulders of the panel with file marks.

The panels on the bottom frame (bottom of the cabinet) are cut from ½" plywood. Since these panels will be the "floor" of the cabinet, the shoulder of the rabbet should fit snugly against the frame. (These plywood panels are very stable compared to solid wood panels, so they can be glued into the groove.)

ASSEMBLING THE FRAMES

Gluing up these four frames requires three pipe (or bar) clamps, one at each rail. If you've cut your mortise and tenon joints so they fit snugly, (hand tight, not force-fit with a hammer) there should be no need to clamp the cheeks of each joint. As glue is applied, the tenon will swell slightly and provide the necessary force to secure the joint.

I used *Elmer's* Carpenter's Glue to assemble these frames. With this type of glue you have a *maximum* of 10 minutes for assembly before the glue sets up. This is plenty of time if everything is laid out properly. (If you feel you need more time, switch to a plastic resin glue for up to 25 minutes assembly time.)

JOINING THE SURROUND

Full blind miter and spline joints are used to join the four frame and panel units of the surround. This involves mitering the ends of the four frame units and cutting a blind groove for a ⅛" plywood spline. (A detailed explanation of this joint is given in *Woodsmith* Number Seven.)

Cutting a 45° miter in a 17"-wide frame can be a little tricky. I did it by flipping the miter gauge end-for-end (180°), and placing it in the right-hand groove of the table saw. The far edge of the frame is held against the miter gauge, giving more room and control at the front of the saw.

A ¼" x ¼" rabbet is cut along the back of each frame to accept the cabinet's back. When these cuts are complete, dry-clamp the surround together with a couple of band clamps. Now you can get the measurements for the web frame.

THE WEB FRAME

The frame assembly that supports the drawers is commonly called a web frame. It's built the same way as the other frames, with three exceptions. First, the panels (dust panels) need only be ¼" plywood.

The second exception is the addition of drawer guides. Since the sides of this cabinet are frame and panel, there is no suitable way to attach side-mounted drawer guides. So a center guide is used on the bottom of the drawers.

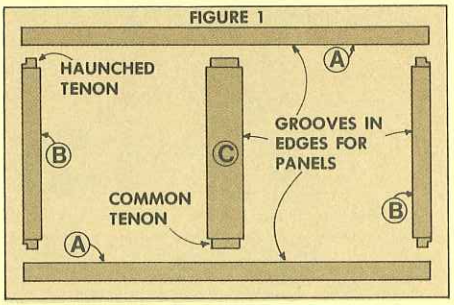
And the third exception: double tenons are cut in the ends of the frame's stiles and fit into double mortises in the side frame assemblies.

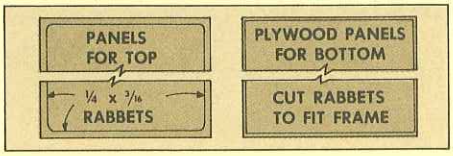
MATERIALS LIST: TOP & BTM FRAMES

Code	Piece	Shld.	Dimensions
A	Stile		¾ x 1½ - 34¼
B	End Rail	14	¾ x 1½ - 16
C	Middle rail	14	¾ x 3 - 16
D	Panel*		½ x 14⅜ - 14½

*Panel in top is solid; in bottom, plywood

FIGURE 1



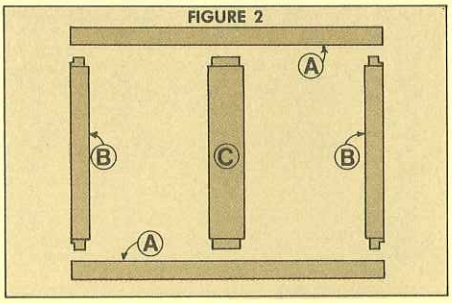


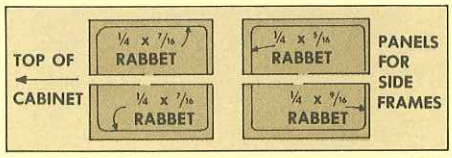
MATERIALS LIST: SIDE FRAMES

Code	Piece	Shld.	Dimensions
A	Stile		¾ x 1½ - 26
B	End Rail	14	¾ x 1½ - 16
C	Middle rail	14	¾ x 3 - 16
D	Panel*		½ x 10⅜ - 14⅜

*Cut ⅜" wider and longer than opening.

FIGURE 2





While the surround is dry-clamped, measure the actual width of the opening. To this add at least 1" to get the length of the stiles for the web frame. (This allows for the ½" double tenons at each end of the stiles.)

I marked and cut the double mortises in the sides of the cabinet first. These mortises are cut to the dimensions as shown in Detail A. The double tenons are then cut to fit the mortises. (The mortises are positioned so the opening for the doors is 16" square.)

Now you can proceed with the construction of the web frame. I kept the shoulder to shoulder measurement of the rails of the web frame the same as that for the surround frames. But since there will be a ¼" plywood back on this cabinet, the stile at the back of the web frame is trimmed ¼" narrower, *after* the tenons are cut.

Detail B shows the cutting sequence for the drawer guide. In effect you have two tenons at the ends of the guide. The bottom tenon fits into the groove in the stile, and the top tenon extends ½" over the top of the stile. The bottom edges of this guide are rabbeted to accept the ¼" dust panels.

When assembling the web frame, make sure the drawer guide is perpendicular to the front edge of the front stile. Before the glue sets up, check the square of the drawer guides and tack them in place (front and back) with small brads.

ASSEMBLY OF THE CARCASS

You're almost ready for assembly of the carcass. The only thing that remains is to cut and fit the divider stiles between the drawers and doors.

A double mortise and tenon is used to join these stiles to the web frame and to the top and bottom of the cabinet.

Loosen the band clamps around the surround and insert the web frame. Now you can get the measurements for the stiles. Measure the *height* of the door and drawer openings. (The door opening should be 16" and the drawer opening 7-¾".) This distance is the shoulder to shoulder length of the stiles. Add 1" for the ½" tenon at each end. Cut the mortises and then cut the tenons.

Where the upper and lower stiles meet at the web frame (Detail D), the tenons should be trimmed to a little less than ⅜". And, both stiles at the *back* of the cabinet are trimmed to 1¼" wide to allow for the cabinet's back.

At last, all of the units that form the structure of the carcass are cut, they all fit properly, and you've collected enough pipe clamps and band clamps to hold it together. You're ready for assembly.

The entire assembly of the carcass goes together at once . . . and you don't have much time before the glue begins to set. You must work quickly, but carefully. You may want to ask a friend to lend a helping hand. Think about what you're each going to do, talk about it, and then do it. With confidence.

I used *Elmer's* Carpenter's Glue for this assembly, but you may want to switch to plastic resin glue for more time during assembly.

With that little flurry of activity, the carcass is assembled. Next come the doors, drawers, and the base.

THE BASE

The base of this cabinet is recessed on the front and both sides. Thus, the entire cabinet seems to "float", just as the panels "float" in the frames.

The base is 3" high and cut to fit the bottom of the cabinet. As shown in Detail C, the base is flush with the back, recessed 3" from the front edge, and recessed ¾" on the sides.

The ends of the four base pieces are mitered and then joined with ⅛" plywood splines. This assembly is glued and allowed to dry before being attached to the bottom of the cabinet.

I attached the base to the cabinet with 1½" screws, drilling a counterbore at a 60° angle starting ¾" up from the bottom of the cabinet.

THE DOORS

Once you've made it this far in the assembly, the doors are a snap. Measure the opening for the doors to get the dimensions for the rails and stiles. (The opening should be 16" x 16".)

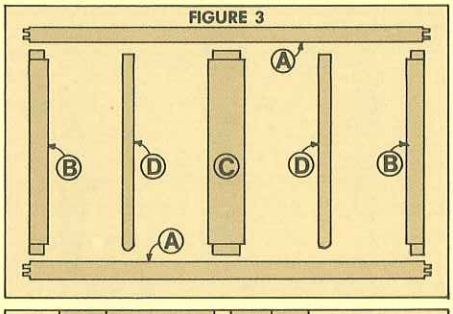
In general when the doors are flush-fit, as on this cabinet, you should allow some space for expansion. However, since the doors (and drawers) are frame and panel, they are quite stable, so you don't need much of a gap.

I cut the doors about 1/16" smaller than the height of the opening (thus allowing about 1/32" on the top and bottom) and the full width of the opening. Then I beveled the latching side of the door (leaving the hinge side square). This beveling allows

MATERIALS LIST: WEB FRAME

Code	Piece	Shld.	Dimensions
A	Stile		¾ x 1½ - 33¾
B	End Rail	14	¾ x 1½ - 16
C	Middle Rail	14	¾ x 3 - 16
D	Drawer Guide		¾ x 1 - 15
E	Dust Panel		¼ x 6⅝ - 14⅜

FIGURE 3



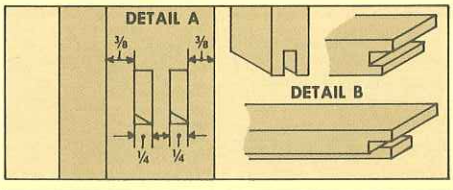
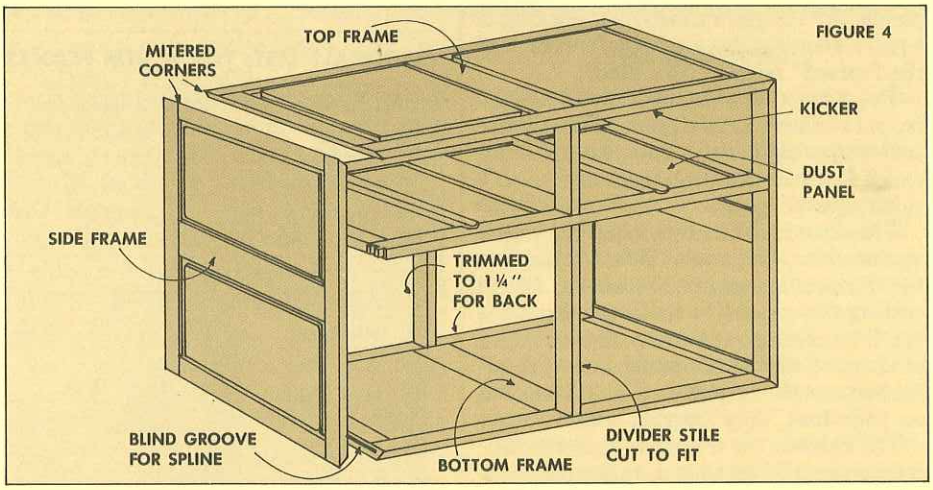
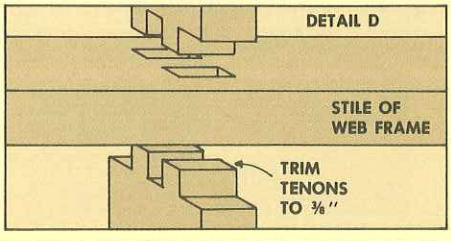
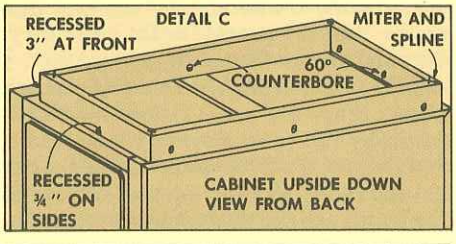


FIGURE 4







for a very close fit at the very front edge of the door, yet permits the door to clear the dividing stile.

THE DRAWERS

The drawer fronts are cut the same way as the doors. For the drawer's sides, you have your choice of ½" finish grade pine or ½" plywood, depending on availability and the final appearance you want.

The drawer fronts of this cabinet are 7¾" high. But I cut the drawer sides to only 7" high. This allows you to pile stuff in the drawer up the top of the sides without interference when opening and closing the drawer.

I used a variation on the mortise and tenon joint to join the sides to the front: a dovetail tenon and groove. This type of joint is most easily cut with a router mounted on a table. (See *Woodsmith* Number Five.) First cut a clean-out groove with a ¼" straight bit, Fig. 6. (This cleans out most of the wood so you don't have to force the dovetail bit.) Stop this groove ¾" from the top.

While you have the ¼" straight bit in the router, you can go ahead and cut the blind groove for the drawer's bottom. Keep the fence of the router table in the same position and cut the grooves in the drawer sides for the bottom. You can also cut the ½"-wide dado for the drawers back by making two or three passes with the ¼" straight bit.

Now switch over to a ½" dovetail bit. Cut the stopped dovetail grooves in the drawer fronts. The next step is to cut a dovetail tenon at the ends of the drawer sides. This sounds like a real hassle, but it's not difficult at all if you use the router table.

First cut the outside face of the drawer side, Detail G. Hold the drawer side firmly against the fence and slide it along to cut half of the dovetail tenon. While you're doing this, use a piece of scrap left over from the drawer side, and make this same cut on it.

The second cut is critical because it actually determines the fit of the dovetail tenon in the groove. I have best results if I kind of sneak up on this cut. Set the fence to cut the dovetail tenon in the try-piece — just a hair wider than necessary to fit in the groove. Hold this dovetail up to the groove in the drawer front and eyeball how much more to take off. Keep sneaking up on the fit like this until you've got it.

The dovetail tenon should fit snugly into the groove, but definitely not force fit. As glue is applied the tenon will swell slightly, so you don't want the original fit too tight.

With the drawers assembled, all that remains is the drawer guide. The rail part of the guide is already attached to the web frame. The channel portion is cut and attached to the bottom of the drawer, Detail F.

I cut this channel guide from ½" pine. It is 1½" wide and the full length of the drawer's bottom. A ¼" deep by 1" wide groove is cut down the center to fit over the rail in the web frame. (Wax both of these parts to help the action.)

STOPS AND KICKERS

The drawer now fits perfectly, with two small problems. It slides in too far when closed, and the front drops down too far when open. So, slide the drawer in so the front is flush with the front of the cabinet. Then glue drawer stops at the back end of the drawer's sides so the drawer will stop with the front flush.

To prevent the drawer front from dropping down too far when open, screw a strip of wood to the bottom of the top frame directly above the drawer guide. The clearance between this "kicker" and the top edge of the drawer's back should be less than 1/16".

FINISHING

The finish for this cabinet is of course optional. My personal preference is to apply a finish that protects the wood, but that is almost invisible. (I like to see the wood, not the finish.) So, I used a white shellac polish.

To make the polish, I used 3-lb.-cut white shellac and cut it down even further: two parts shellac with three parts denatured alcohol. With a solution this diluted, you have to apply at least four coats, but they dry very quickly (20 to 30 minutes). Sand in between coats with 320 grit silicon carbide paper, and after the final coat use 400 grit paper.

Make sure you apply the finish to both the inside and outside of the cabinet. This will prevent one side from absorbing moisture in the air more quickly than the other side, causing it to warp. Finally, this shellac finish is very susceptible to water stains, so I finished off with a couple of coats of a carnauba furniture wax.

MATERIALS LIST: DOOR AND DRAWER

Code	Piece	Shld.	Dimensions
A	Stile		¾ x 1½ - 16
B	Rail	14	¾ x 1½ - 15
C	Panel		½ x 13⅜ - 13⅜
	DRAWER		
A	Stile		¾ x 1½ - 7¾
B	Rail	14	¾ x 1½ - 15
C	Panel		½ x 5⅛ - 13⅜
D	Side		½ x 7 - 15½
E	Bottom		¼ x 15 - 15⅛
F	Back		½ x 6¼ - 15

FIGURE 5

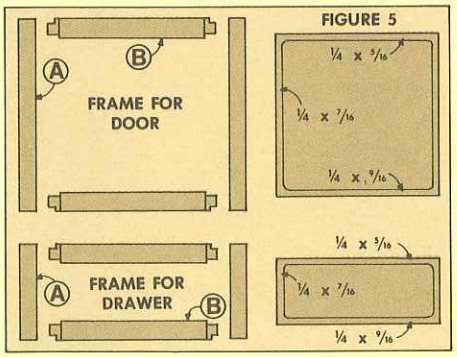
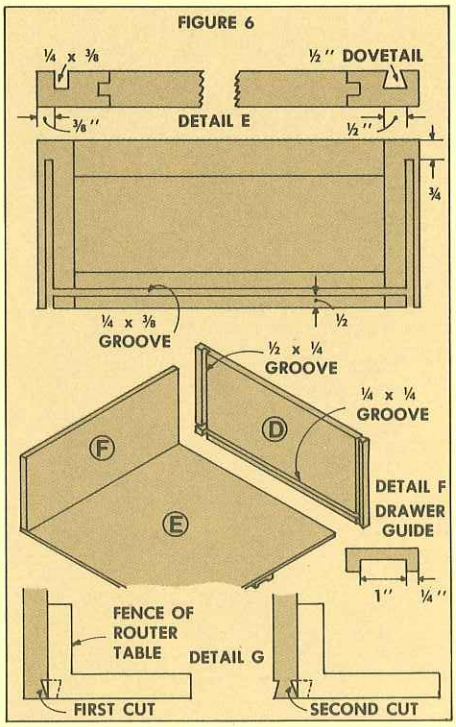
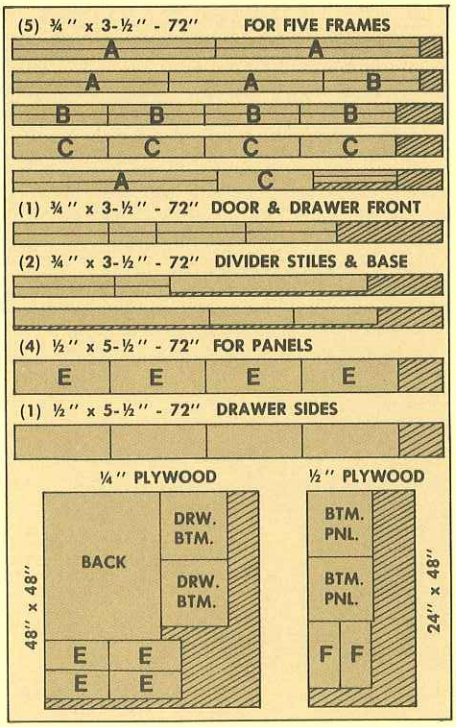


FIGURE 6





Panel Cutting

TWO TECHNIQUES FOR CUTTING WIDE PANELS

One of the most difficult operations on a table saw is making a cut at the end of a long, wide workpiece. Actually, you're faced with two problems. The first problem is holding the workpiece on the table, which is at best awkward. If the piece is very wide, the miter gauge hangs over the front edge of the table and begins to wobble.

The next problem is making a true (square) cut. Though your cut starts out okay, by the time you've gone through a wide board you can be off by ⅛" or more. Hold-down apparatus on the miter gauge helps to some extent, but you're still faced with the "wobble" problem.

The difficulty in making a true cut in a wide board is caused by the action of the blade. The teeth of the blade tend to pull the board into the blade (particularly if the teeth have "set"), thus making a slightly tapered cut.

When faced with cutting wide pieces, I use one of the two techniques shown in the drawings at right. Figure 1 shows a simple jig to hold the workpiece steady and square with the blade. This jig is simply a piece of ½" plywood (mine is 18" by 48") fastened to a guide bar that slides in the groove of the table. A 1x2 fence is fastened to the front edge of the plywood base.

I cut the guide bar out of some scrap maple and trimmed it to fit snugly in the groove. The plywood base is placed over the guide bar leaving ½" extending over the line of the blade. After attaching the base to the guide bar with ¾" woodscrews, cut off the end of the base.

To attach the 1x2 fence on the front edge of the jig, drive two 1¼" brads so they just barely poke through. Raise the blade to its full height and use a framing square to position the fence, square with the blade. Then drive enough brads to secure the fence.

When using this jig, cut the workpiece to the approximate length, leaving about ½" to 1" extra. Then mark the length of the cut along the 1x2 fence. At the marked length clamp a small stop block to the fence. Now when you make the cut, push the workpiece *toward the stop.* This prevents the workpiece from "creeping" into the blade.

The jig in Figure 2 is even simpler. In this case you rotate the miter gauge 180° and clamp a long stick with a stop block attached to the end.

By rotating the miter gauge you keep its head firmly on the table when starting the cut. And, as with the first jig, the workpiece is pushed against the stop (away from the blade) to prevent "creeping".